

## Parasitism of Cottontail Rabbits (*Sylvilagus floridanus*) by *Obeliscoides cuniculi* in Response to Habitat Modification in the Cross Timbers of Oklahoma

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**ABSTRACT:** The influence of habitat modification on populations of *Obeliscoides cuniculi* in cottontail rabbits (*Sylvilagus floridanus*) was examined from 1987 to 1988 in the Cross Timbers ecosystem of Oklahoma. Five experimental brush control treatments, using combinations of the herbicides tebuthiuron and triclopyr with or without prescribed burning, were replicated 4 times on 20 32.4-ha pastures. Two hundred five rabbits (25 juvenile and 180 adult) were collected with an overall prevalence of infection of 97%. Prevalence in adult hosts apparently was not influenced by brush treatment, season, or year. Distribution of populations of *O. cuniculi* within cottontail rabbits was influenced significantly by season, with a higher degree of overdispersion in winter. The influence of brush treatment on the degree of overdispersion was not clear, but seasonal variation was low on untreated control pastures. Abundance of infections of *O. cuniculi* was significantly affected by brush treatment, season, and year of collection. Mean abundances were lower on annually burned pastures treated with triclopyr than on all other experimental pastures. Abundance of *O. cuniculi* in cottontail rabbits was higher in summer ( $58.8 \pm 7.0$ ) than winter ( $23.0 \pm 4.4$ ). Variations in the intensity of the prescribed burns and in season were probably important factors that influenced parasitism of cottontail rabbits by *O. cuniculi*.

**KEY WORDS:** cottontail rabbit, *Sylvilagus floridanus*, brush management, *Obeliscoides cuniculi*, Trichostrongylidae, herbicides, prescribed burning, tebuthiuron, triclopyr.

Parasitism in wildlife populations is strongly influenced by the type of habitat in which the host resides (Custer and Pence, 1981; Pence et al., 1983; Corn et al., 1985). Geographic variation in communities of helminths in wildlife appears to be associated in part with changes in selected habitat attributes. For example, Mollhagen (1978) suggested that the composition of the helminth community in cotton rat (*Sigmodon hispidus*) populations in Texas was influenced by moisture characteristics of the habitat. Similarly, Kinsella (1974) reported significant differences in prevalence and abundance of nematodes and cestodes among populations of cotton rats in freshwater marshes, saltwater marshes, and relatively xeric upland habitats from north-central to south-central Florida. Jacobson et al. (1978) noted significant differences in abundances of nematodes and cestodes in populations of eastern cottontail rabbits (*Sylvilagus floridanus*) between southeast and southwest Virginia; however, these 2 areas differed markedly in altitude, topography, length of growing season, soil pH, and land management practices, which made interpretation difficult.

Although previous studies demonstrate a strong

relationship between parasite communities of a host and habitat attributes when compared across geographic regions, they provide little insight into host-parasite relationships following habitat alterations in a local area. Natural and human-induced successional changes are a common component of wildlife habitats. Intensive land-use and range/wildlife improvement practices are capable of drastic alterations of both the structure and composition of wildlife habitat, especially in the vegetative component. Management techniques such as prescribed burning and herbicide applications are routinely used to reverse succession across large areas of habitat, with lasting effects. Changes in physical and biological attributes of habitat undoubtedly occur following intensive treatments such as these and potentially can alter host-parasite community ecology.

Our understanding of effects of local habitat modification on host-parasite relationships is limited. Issac (1963) discovered that diseases of black-tailed deer (*Odocoileus hemionus columbianus*) caused by liver flukes and lungworms were curtailed by the Tillamook burn in Oregon in 1933. Bendell (1974) found that although internal and external parasitism of blue grouse

(*Dendragapus obscurus*) initially decreased following an intense wildfire, parasite species richness and frequency of infection increased 12 yr later. Forrester et al. (1987) suggested that agricultural practices, including prescribed burning and herbicide treatment, affected the helminth parasitism of round-tailed muskrats (*Neofiber aleni*).

*Obeliscoides cuniculi* (Graybill, 1923) is a common trichostrongylid stomach worm of cottontail rabbits that is widely distributed in North America (Ward, 1934; Morgan and Waller, 1940; Moore and Moore, 1947; Franklin et al., 1966; Stringer et al., 1969; Andrews et al., 1980; Strohl and Christensen, 1983). Several studies on *O. cuniculi* have reported on life history (Alicata, 1932), effects on nutritional physiology of rabbits (Pace and Fransden, 1982), seasonal variation (Gibbs et al., 1977), and arrested development (Michel et al., 1975). However, only one study has reported the distribution, abundance, and ecological relationships of this trichostrongylid nematode within the Cross Timbers ecosystem of central Oklahoma (Ward, 1934) where range improvement practices are commonly used. Our objective was to determine if brush management strategies using combinations of fire and herbicides influence the distribution, abundance, or prevalence of *O. cuniculi* infections in populations of cottontail rabbits in the Cross Timbers ecosystem of Oklahoma.

## Materials and Methods

### Study area

Our study was conducted on the Cross Timbers Experimental Range (CTER), which is located approximately 11 km west of Stillwater, Oklahoma. The CTER is a 648-ha research area originally composed of black-jack oak (*Quercus marilandica*)–post oak (*Q. stellata*) and eastern redcedar (*Juniperus virginiana*) upland forest intermixed with tall grass prairie (Ewing et al., 1984). The CTER includes 20 32.4-ha (0.42- × 0.83-km) fenced experimental pastures, representing 4 replications of 4 brush management treatments, using combinations of herbicide and annual prescribed burning, and an untreated control. This provides a 2 × 2 factorial design consisting of 4 replications of 5 treatments (Fig. 1). The experimental treatments included (1) tebuthiuron (N-[1,1-dimethyl-ethyl]-1,3,4-thiadiazol-2-yl]-N,N'-dimethylurea), a soil-applied herbicide (Elanco Products Co., Division of Eli Lilly and Co., Indianapolis, Indiana 46285) applied aerially at 2.0 kg/ha in March 1983; (2) tebuthiuron applied (as with treatment #1) with annual prescribed burning beginning in April 1985; (3) triclopyr ([3,5,6-trichloro-2-pyridinyl)oxy]acetic acid), a foliage-applied herbicide (Dow Chemical Co., Midland, Michigan 48674) ap-

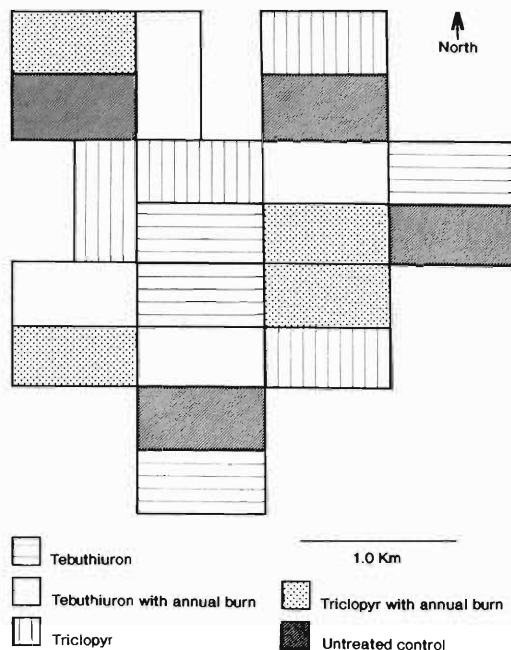


Figure 1. Map of the Cross Timbers Experimental Range, Payne County, Oklahoma, consisting of 20 experimental pastures representing 4 replications of 4 brush treatments and an untreated control.

plied aerially at 2.2 kg/ha in June 1983; (4) triclopyr applied (as with treatment #3) with annual prescribed burning beginning in April 1985; and (5) untreated control. None of the treated areas were burned in 1988. All experimental pastures were moderately grazed by cattle during the spring and summer.

Herbicide-treated pastures produced more grasses and forbs compared to untreated control pastures (Engle et al., 1987). Both herbicides killed a high proportion of the dominant overstory oak species, but woody understorey species such as buckbrush (*Symphoricarpos orbiculatus*), elm (*Ulmus americana*), and chittamwood (*Bumelia lanuginosa*) were not reduced as much by triclopyr as by tebuthiuron (Stritzke et al., 1987). Competition by understorey woody species reduced the production of herbaceous plants after the triclopyr treatment.

### Data collection

Two hundred five cottontail rabbits (*Sylvilagus floridanus* (Allen)) were collected during winter (January) and summer (July) of 1987 and 1988. An attempt was made to collect 5 specimens from each of 2 replications for each treatment. Carcasses were necropsied within 24 hr of collection or frozen until necropsy could be performed. Stomach worms that were recovered from the gastric mucosa and food contents were counted and stored in 70% ethanol. Specimens of *O. cuniculi* were cleared with lactophenol and identified by microscopic examination. Representative specimens of *O. cuniculi* recovered from this study were deposited in the U.S.

National Parasite Collection, Beltsville, Maryland (accession no. 80494).

### Data analysis

Abundance and prevalence were used as defined by Margolis et al. (1982). Host age was determined using a combination of reproductive status and body weight. Cottontail rabbits  $\geq 800$  g body weight and reproductively active individuals between 650 and 799 g were considered adults. Only abundance data for adult cottontail rabbits ( $N = 180$ ) were used in data analyses for the main effects of treatment, season, year, and sex.

Overdispersion as defined by Bliss and Fisher (1953) has been used to describe frequency distributions of helminths in which a small number of host individuals harbor many helminth individuals and many hosts harbor few or no individuals of a particular species of helminth (Corn et al., 1985; Waid et al., 1985). Overdispersion was indicated when helminth frequency distributions had a variance significantly larger ( $P \leq 0.05$ ) than the mean abundance, using a chi-square distribution. The degree of overdispersion was measured by the negative binomial parameter  $k$  (Bliss and Fisher, 1953), which is an inverse measure of the degree of overdispersion. Differences in overdispersion ( $k$ ) among brush treatments and seasons were then evaluated by analysis of variance using Anscombe's transform,  $\log_{10}(x + \frac{1}{2}k)$ , of abundance data (Bliss and Owen, 1958). Overdispersed *O. cuniculi* abundances for the adult cottontail rabbits were independently rank transformed prior to data analysis as a method to analyze nonnormally distributed data (Conover and Iman, 1981; Waid et al., 1985).

Main and interactive effects of treatment, season, and year on rank-transformed abundances were examined with a factorial analysis of variance. Biological significance was set at  $P \leq 0.100$ . Specific contrasts (1 df) were utilized to compare variation among treatment components (burned vs. unburned, untreated control vs. brush treatments, tebuthiuron vs. triclopyr). Protected multiple comparisons (LSD) were used when significant ( $P \leq 0.05$ ) differences were detected by analysis of variance. The Statistical Analysis System (SAS) was used for all data analyses (SAS, 1985). Copies of the raw and rank-transformed data are available upon request from R.L.L.

## Results and Discussion

### Prevalence

Ninety-five male (86 adult) and 110 female (94 adult) cottontail rabbits were collected from the CTER with an overall prevalence of 97% for *O. cuniculi* (Table 1). Juvenile cottontail rabbits ( $N = 25$ ) were not included in data analyses because of significant differences in *O. cuniculi* mean abundances ( $P \leq 0.001$ ) when compared with adults. Prevalence of *O. cuniculi* infections in our study was higher than other studies in Oklahoma where Ward (1934) and Smith (1940) reported prevalences of 47% and 0% in samples of 52 and

31 cottontail rabbits, respectively. Franklin et al. (1966) found a prevalence of 16% in a sample of 138 cottontail rabbits from Kansas, and Measures and Anderson (1983) reported a prevalence of 15% in southern Ontario. *Obeliscoides cuniculi* infections in our study were similar to those in surveys in the southeastern United States where prevalences approached 100% (Moore and Moore, 1947; Jacobson et al., 1978; Andrews et al., 1980). No differences in prevalence were found among cottontail rabbits from the brush treatments or controls.

### Distribution and overdispersion

Variances were significantly larger than the mean number of *O. cuniculi* individuals/adult cottontail rabbit for all treatments in each season (Table 2), which was indicative of an overdispersed parasite distribution (Bliss and Fisher, 1953). Low  $k$  values ( $\leq 1.0$ ) indicated a high degree of parasitic aggregation (Bliss and Fisher, 1953; Corn et al., 1985) within our host population, but there was no significant difference ( $P \geq 0.100$ ) in  $k$  values due to brush treatment. Cottontail rabbits from herbicide-treated pastures showed a greater amount of variation in  $k$  values between seasons than those from untreated control pastures. Common  $k$  statistics from 1988 indicated differences ( $P < 0.055$ ) in *O. cuniculi* overdispersion between control and brush-treated pastures. Degree of overdispersion was significantly greater ( $P < 0.001$ ) in winter than summer for both years. The  $k$  value of 25 juvenile cottontail rabbits that were collected primarily in summer was 2.90.

Distribution of *O. cuniculi* infections in cottontail rabbit populations in the Cross Timbers area supports previous studies that indicate seasonal changes foster overdispersion (Pence and Windberg, 1984; Corn et al., 1985). However, other factors such as habitat heterogeneity (Anderson, 1982) could also be important in overdispersion in *O. cuniculi* as indicated by differences in the seasonal variation of  $k$  values between treated and untreated pastures. Natural successional changes, vegetative composition, patchiness of treatments, and microclimates occurring on herbicide-treated pastures could have contributed to these observed differences as compared with untreated controls. Intrinsic host-related variables such as habitat use by cottontails also may be factors that contribute to overdispersion of *O. cuniculi* on our study area.

**Table 1. Prevalence (number infected/number examined) of *Obeliscoides cuniculi* in cottontail rabbits collected from 5 experimental brush-control treatments on the Cross Timbers Experimental Range, Payne County, Oklahoma.**

Brush treatment	1987		1988	
	Winter	Summer	Winter	Summer
Tebuthiuron	10/10	10/10	13/13	10/10
Tebuthiuron with annual burning	10/11	10/10	9/10	10/10
Triclopyr	10/10	10/10	10/10	10/10
Triclopyr with annual burning	9/10	10/10	10/10	10/10
Control	9/10	11/11	9/10	10/10
Total	48/51	51/51	51/53	50/50

**Abundance and intensity**

Infection intensities ranged from 1 to 435 worms/host; only 5 uninfected rabbits were observed in the winters of 1987 and 1988. Mean *O. cuniculi* abundances (Table 3) were significantly different between seasons ( $P < 0.001$ ), treatments ( $P < 0.057$ ), and years ( $P < 0.053$ ), and a significant ( $P < 0.013$ ) brush treatment  $\times$  year interaction occurred. Mean rank abundances were considerably higher in summer than in winter for both years sampled. Mean abundances for *O. cuniculi* across all treatments were  $58.8 \pm 7.0$  and  $23.0 \pm 4.4$  worms/host (wph) for summer and winter, respectively. Mean abundance was higher in 1987 ( $42.8 \pm 5.8$  wph) than 1988 ( $34.0 \pm 5.8$  wph).

Mean rank abundances of *O. cuniculi* in cottontail rabbits collected in 1988 from annually burned treatments ( $48.0 \pm 3.7$  wph) were lower

( $P < 0.040$ ) than those from unburned experimental treatments ( $41.1 \pm 4.2$  wph). Multiple comparisons among treatments showed triclopyr treatments subjected to annual prescribed burning had a mean rank abundance for *O. cuniculi* that was lower ( $P < 0.050$ ) than the other 4 treatments. Abundances of *O. cuniculi* were not different ( $P > 0.230$ ) between triclopyr- and tebuthiuron-treated pastures in 1987 or 1988. There were no significant ( $P > 0.150$ ) differences in abundances between control and treated pastures for 1987.

Seasonal differences between winter and summer *O. cuniculi* abundances in cottontail rabbits are well documented across the United States. Andrews et al. (1980) found that *O. cuniculi* abundances in cottontail rabbits collected in spring were 2–4 times greater than those in winter. Jacobson et al. (1978) reported similar results for cottontail rabbits from Virginia and speculated that variable climate and host hormonal changes influenced *O. cuniculi* abundance. In our study, seasonal variation was more profound during 1988 than 1987, as demonstrated by a larger summer/winter ratio of mean rank abundance. This was probably due to a harsh winter in 1988, during which record snowfalls and ice storms were recorded. The winter of 1987 was mild and wet and probably provided optimal conditions for parasite transmission (Alicata, 1932), resulting in less variation in intensities of helminths between seasons.

**Management implications**

Effects of wildfire and prescribed burning on helminth parasitism have not been well docu-

**Table 2. Determination of overdispersion ( $\bar{x}/s^2$ )\* and degree of aggregation ( $k$ ) of *Obeliscoides cuniculi* individuals in adult cottontail rabbits collected from 5 experimental brush-control treatments on the Cross Timbers Experimental Range, Payne County, Oklahoma ( $N = 180$ ).**

Brush treatment	1987				1988				Total
	Winter		Summer		Winter		Summer		
	$\bar{x}/s^2$	$k$	$\bar{x}/s^2$	$k$	$\bar{x}/s^2$	$k$	$\bar{x}/s^2$	$k$	
Tebuthiuron	0.091	0.03	0.023	1.30	0.027	0.93	0.044	2.37	0.95
Tebuthiuron with annual burning	0.011	0.54	0.047	2.74	0.153	1.34	0.055	0.45	0.40
Triclopyr	0.005	0.30	0.024	1.25	0.100	1.16	0.030	1.84	0.49
Triclopyr with annual burning	0.146	1.51	0.017	0.74	0.045	0.52	0.061	2.13	0.58
Control	0.027	1.00	0.018	1.12	0.205	1.03	0.019	1.17	0.67

\*  $\bar{x}$  abundance/variance, where a small number of host individuals harbor many parasite individuals and many of the hosts harbor little to no individuals of a particular parasitic species (based on the frequency distribution of individual parasites). All variances were significantly larger than respective  $\bar{x}$  abundances ( $P \leq 0.05$ ).

Table 3. Mean seasonal abundance ( $\bar{x} \pm \text{SE}$ ) of *Obeliscoides cuniculi* in cottontail rabbits collected from 5 experimental brush-control treatments on the Cross Timbers Experimental Range, Payne County, Oklahoma. Sample size is in parentheses.

Brush treatment	1987						1988					
	Winter			Summer			Winter			Summer		
	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile
Tebuthiuron	10.3 $\pm$ 3.4 (10)	NC*	54.4 $\pm$ 16.1 (10)	3.0 (1)	33.5 $\pm$ 9.7 (13)	NC	51.9 $\pm$ 12.2 (10)	NC	90.6 $\pm$ 45.2 (10)	32.0 $\pm$ 31.0 (2)	67.0 (1)	75.5 $\pm$ 23.0 (4)
Tebuthiuron with burn	49.2 $\pm$ 20.3 (11)	NC	55.4 $\pm$ 11.4 (10)	101.0 (1)	7.4 $\pm$ 2.2 (10)	NC	59.3 $\pm$ 18.1 (10)	NC	33.0 $\pm$ 8.8 (10)	82.3 $\pm$ 7.4 (3)	60.7 $\pm$ 18.8 (10)	78.0 (1)
Triclopyr	56.9 $\pm$ 34.9 (10)	36.0 (1)	65.4 $\pm$ 18.3 (10)	54.4 $\pm$ 49.5 (2)	10.4 $\pm$ 3.2 (10)	NC	11.0 $\pm$ 4.9 (10)	NC	60.7 $\pm$ 18.8 (10)	78.0 (1)		
Triclopyr with burn	8.8 $\pm$ 2.5 (10)	NC	43.8 $\pm$ 23.0 (10)	73.0 $\pm$ 10.0 (5)	11.0 $\pm$ 4.9 (10)	NC	4.0 $\pm$ 1.4 (10)	NC				
Control	36.3 $\pm$ 11.6 (10)	NC	61.6 $\pm$ 22.1 (11)	28.5 $\pm$ 6.1 (4)	4.0 $\pm$ 1.4 (10)	NC						

\* NC = no rabbits collected.

mented. Habitat modifications induced by wild-fire can produce optimal conditions for establishment of arthropod intermediate hosts of pathogenic intestinal worms of blue grouse (Bendell, 1974). Prescribed fire for habitat management of Stone's sheep (*Ovis dalli stonei*) decreased *Protostrongylus* sp. larval counts in feces of sheep that utilized burned ranges during winter (Seip and Bunnell, 1985). Cottontail rabbits in our study area experienced similar host-parasite influences from 1987 to 1988. Prescribed burning at CTER occurred in April when infective larvae and eggs should have been abundant in the environment and conditions for transmission were ideal. Burning may have decreased the number of these infective stages available to foraging cottontail rabbits, which resulted in lower mean abundances among animals collected from burned sites. This was found to be true of rabbits collected from triclopyr-treated pastures that were burned annually. Spotty, nonuniform burns resulting from a lack of adequate fuel were probably responsible for higher survival of infective *O. cuniculi* larvae on annually burned tebuthiuron-treated pastures.

Our study provided additional evidence that habitat alterations, whether natural or human induced, can influence host-parasite population relationships in a local area. Host-parasite responses to a given habitat alteration are not always consistent; however, our study demonstrates they differ from those responses in untreated habitats. Because habitat modification practices, such as those using herbicides and fire, vary greatly in their effects on vegetation structure and how they are applied, general statements about host-parasite responses may be difficult to make. Longer-term research on entire helminth communities is needed to understand better and predict these responses.

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## Literature Cited

- Alicata, J. E.** 1932. Life history of the rabbit stomach worm, *Obeliscoides cuniculi*. Journal of Agricultural Research 44:401-419.
- Anderson, R. M.** 1982. Host-parasite population biology. Pages 303-312 in D. F. Mettrick and S. S. Desser, eds. Parasites—Their World and Ours. Elsevier Biomedical Press, Amsterdam.
- Andrews, C. L., W. R. Davidson, and E. E. Provost.** 1980. Endoparasites of selected populations of cottontail rabbits (*Sylvilagus floridanus*) in the southeastern United States. Journal of Wildlife Diseases 16:395-401.
- Bendell, J. F.** 1974. Effects of fire on birds and mammals. Pages 73-138 in T. T. Kozlowski and C. E. Ahlgren, eds. Fire and Ecosystems. Academic Press, New York.
- Bliss, C. I., and R. A. Fisher.** 1953. Fitting the negative binomial distribution of biological data. Biometrics 9:176-200.
- , and **R. G. Owen.** 1958. Negative binomial distributions with a common *k*. Biometrika 45: 37-58.
- Conover, W. J., and R. Iman.** 1981. Rank transformations as a bridge between parametric and non-parametric statistics. The American Statistician 35:124-129.
- Corn, J. L., D. B. Pence, and R. J. Warren.** 1985. Factors affecting the helminth community structure of adult collared peccaries in southern Texas. Journal of Wildlife Diseases 21:254-263.
- Custer, J. W., and D. B. Pence.** 1981. Helminths of wild canids from the Gulf Coastal prairies of Texas and Louisiana. Journal of Parasitology 67:289-307.
- Engle, D. M., J. F. Stritzke, and F. T. McCollum.** 1987. Brush management on the Cross Timbers Experimental Range: herbaceous plant responses. Oklahoma Agriculture Experiment Station MP-119:103-109.
- Ewing, J. H., J. F. Stritzke, and J. Kulbeth.** 1984. Vegetation of the Cross Timbers Experimental Range, Payne County, Oklahoma. Research Report P-856, Agriculture Experiment Station, Oklahoma State University, Stillwater, Oklahoma. 40 pp.
- Forrester, D. J., D. B. Pence, A. O. Bush, D. M. Lee, and N. R. Holler.** 1987. Ecological analysis of the helminths of round-tailed muskrats (*Neofiber alleni* True) in southern Florida. Canadian Journal of Zoology 65:2976-2979.
- Franklin, J., M. L. Simmons, and G. E. Cosgrove.** 1966. A pathogen survey in the Kansas cottontail. Bulletin of the Wildlife Disease Association 2:52-53.
- Gibbs, H. C., W. J. Crenshaw, and M. Mowatt.** 1977. Seasonal changes in stomach worms (*Obeliscoides cuniculi*) in snowshoe hares in Maine. Journal of Wildlife Diseases 13:327-332.
- Issac, L. A.** 1963. Fire—a tool not a blanket rule in Douglas-fir ecology. Proceedings of the Tall Timbers Fire Ecology Conference 2:1-17.
- Jacobson, H. A., R. L. Kirkpatrick, and B. S. McGinnes.** 1978. Disease and physiologic characteristics of two cottontail populations in Virginia. Wildlife Monograph No. 60. 53 pp.
- Kinsella, J. M.** 1974. Comparison of helminth parasites of the cotton rat, *Sigmodon hispidus*, from several habitats in Florida. American Museum Novitates 2540:1-12.
- Margolis, L. G., G. W. Esch, J. C. Holmes, A. M. Kuris, and G. A. Shad.** 1982. The use of ecological terms in parasitology (report of an ad hoc committee of the American Society of Parasitologists). Journal of Parasitology 68:131-133.
- Measures, L. N., and R. C. Anderson.** 1983. Characteristics of natural infections of the stomach worm, *Obeliscoides cuniculi* (Graybill), in lagomorphs and woodchucks in Canada. Journal of Wildlife Diseases 19:219-224.
- Michel, J. F., M. B. Lancaster, and C. Hong.** 1975. Arrested development of *Obeliscoides cuniculi*: the effect of size of inoculum. Journal of Comparative Pathology 85:307-315.
- Mollhagen, T.** 1978. Habitat influences on helminth parasitism of the cotton rat in western Texas, with remarks on some of the parasites. Southwestern Naturalist 23:401-408.
- Moore, E. R., and G. C. Moore.** 1947. The helminth parasites of cottontail rabbits in Alabama, with notes on the arthropod *Linguatula serrata*. Journal of Mammalogy 28:270-283.
- Morgan, B. B., and E. F. Waller.** 1940. A survey of parasites of the Iowa cottontail (*Sylvilagus floridanus mearnsi*). Journal of Wildlife Management 4:21-26.
- Pace, R. D., and J. C. Fransden.** 1982. Metabolic effects of infection by the stomach worm *Obeliscoides cuniculi* in rabbits fed diets varying in nutritive quality. Journal of Nutrition 112:2071-2080.
- Pence, D. B., J. M. Crum, and J. A. Conti.** 1983. Ecological analyses of helminth populations in the black bear, *Ursus americanus*, from North America. Journal of Parasitology 69:933-950.
- , and **L. A. Windberg.** 1984. Population dynamics across selected habitat variables of the helminth community in coyotes, *Canis latrans*, from south Texas. Journal of Parasitology 70:735-746.
- SAS.** 1985. SAS User's Guide: Statistics, Version 5 Edition. SAS Institute, Inc., Cary, North Carolina.
- Seip, D. R., and F. L. Bunnell.** 1985. Nutrition of Stone's sheep on burned and unburned ranges. Journal of Wildlife Management 49:397-405.
- Smith, C. C.** 1940. Notes on the food and parasites of the rabbits of a lowland area in Oklahoma. Journal of Wildlife Management 4:429-431.
- Stringer, R. P., R. Harkema, and G. C. Miller.** 1969. Parasites of rabbits of North Carolina. Journal of Parasitology 55:328.
- Stritzke, J. F., D. M. Engle, and F. T. McCollum.** 1987. Brush management on the Cross Timbers Experimental Range: brush problems and responses to herbicides. Oklahoma Agriculture Experiment Station MP-119:99-102.
- Strohlein, D. A., and B. M. Christensen.** 1983. Metazoan parasites of the eastern cottontail rabbit in

western Kentucky. *Journal of Wildlife Diseases* 19:20–23.

**Waid, D. D., D. B. Pence, and R. J. Warren.** 1985. Effects of season and physical condition on the gastrointestinal helminth community of white-

tailed deer from the Texas Edwards Plateau. *Journal of Wildlife Diseases* 21:264–273.

**Ward, J. W.** 1934. A study of some parasites of rabbits of central Oklahoma. *Proceedings of the Oklahoma Academy of Science* 14:31–32.

## 80th Anniversary Celebration



**Society President John H. Cross (left) presenting certificate of gratitude to guest speaker Gerhard A. Schad, President of the American Society of Parasitologists.**

The 80th Anniversary of the Helminthological Society of Washington was celebrated at a dinner held 23 March 1990 at the 610th meeting. Fifty-five members and guests enjoyed dinner followed by a short history of the Society summarized by Willis A. Reid. The guest speaker for the evening was Gerhard A. Schad, President of the American Society of Parasitologists, whose talk was entitled, "The Hookworm's Turn Again."

The Society thanks Merck, Sharp and Dohme Research Laboratories and Smith Kline, Beecham, for their generous support of the event.